MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
(UGC - AUTONOMOUS)

Course Structure and Syllabi

M.Tech. Machine Design [MD]

I YEAR - I Semester

S. No	Course code	Subject	Theory	Lab.	Credits	I.M	E.M	M.M
1.	14MD11T01	Advanced Mechanical Engineering Design	4	0	4	40	60	100
2.	14MD11T02	Advanced Mechanics Of Solids	4	0	4	40	60	100
3.	14MD11T03	Fatigue, Creep & Fracture Mechanics	4	0	4	40	60	100
4.	14MD11T04	Computational Methods	4	0	4	40	60	100
5.	14MD11T05	Theory of Elasticity & Plasticity						
6.		Elective-I	4	0	4	40	60	100
	14MD11E1a	1. Advanced Computer Aided Design						
	14MD11E1b	2. Material Technology						
	14MD11E1c	3. Non-Destructive Evaluation						
	14MD11E1d	4. Tribology In Design						
7.	14MD11P01	Advanced Computer Aided Design &Analysis Lab	0	3	2	40	60	100
		Contact periods/week	24	3				
		Total	**27**		**26**	**280**	**420**	**700**

I YEAR - II Semester

S. No	Course code	Subject	Theory	Lab.	Credits	I.M	E.M	M.M
1.	14MD12T06	Advanced Mechanisms	4	0	4	40	60	100
2.	14MD12T07	Mechanical Vibrations	4	0	4	40	60	100
3.	14MD12T08	Engineering Optimization Techniques	4	0	4	40	60	100
4.	14MD12T09	Experimental Stress Analysis	4	0	4	40	60	100
5.	14MD12T10	Finite Element Analysis	4	0	4	40	60	100
6.		Elective-II	4	0	4	40	60	100
	14MD12E2a	1.Pressure Vessel Design						
	14MD12E2b	2.Robotics						
	14MD12E2c	3.Mechanics Of Composite Materials						
	14MD12E2d	4.Gear Engineering						
7.	14MD12P02	Dynamics Lab	0	3	2	40	60	100
		Contact periods/week	24	3				
		Total	**27**		**26**	**280**	**420**	**700**

II YEAR (III & IV Semesters)

S. No	Course code	Subject	Credits	I.M	E.M	M.M
1.	14MD21S01	Seminar	02	100	--	100
2.	14MD22D01	Project work	16	--	--	--

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(14MD11T01) ADVANCED MECHANICAL ENGINEERING DESIGN

(PSG Design data book is permitted in Examination)

Course Objectives

- Understanding the motion of the component and the basic geometry of the mechanisms.
- The kinematics of machines deals with the motion of members of the mechanisms which includes the determination of velocities and acceleration of the machine members.
- Understanding the process and methods of design of machines and elements.
- Abilities of developing equations pertaining to the design of machines.
- Knowledge of different materials and their properties for designing the components of machine elements.
- Ability to design new machines or modify existing machine according to the need.

Course Outcomes:

After Completion of this course students will be able to

- Apply the knowledge of Mathematics, Science and Engineering for designing machine part.
- Propose the Engineering solutions for global progress, productivity and economic development.
- List the materials and variety of mechanical components available/used to produce every day goods and services.
- Identify and solve the engineering challenges regarding the human needs in daily life about machines and systems.
- List the processes and methods of design of machines and elements.
- Develop equations and relations pertaining to the design of machines
- Develop fundamental knowledge of the Standards used in the design of machine elements
- Design component, machine, workstation and systems etc. for safe working by minimizing accidents and other health hazards.
- List and define functionality of various parts used in Automobiles, working principles and their design which include brakes, Gears, Clutches, and Springs etc.
- List different materials and state their properties
- Design new machines or modify the existing machines according to the need, also use the techniques, skills and modern engineering tools for engineering practice.
- Communicate effectively through written and oral skills.

Unit – I

Introduction: Introduction to design,computer aided design and Engineering, materials, load analysis, stresses, strains, deflection and stability, stress element representation for different types of loads. Locating critical sections, force flow concept, methodology for solving machine component problems.

Failure Theories: Static failure theories-failure of ductile materials, failure of brittle materials, fracture mechanics, fatigue-failure theories, surface failures.

Unit – II

Design synthesis: Introduction to product design, product design practice and industry, designing with plastics, rubber, ceramics & woods: economic factors influencing design, human engineering considerations in product design; Modern approach to product design.

Unit – III

Design of power transmission elements: Design of flat belts, v-belts, toothed belts, roller chains.

Design of Gears-I: Spur, Helical, Gear materials, forces, stresses, lubrication, design procedure considering Lewis beam strength and Problems.

Unit – IV

Design of Gears-II

Design of Spiral , worm and wheel, Bevel gears, Algorithms for the design procedure of different types of gears.

Unit – V

Journal bearings: Lubricants, hydrodynamic lubrication theory, design of hydrodynamic bearings, multi lobe bearings.

Rolling Element Bearings

Rolling element bearings, selection of rolling element bearings, bearing mountings and special bearings. Algorithms for the design procedure of bearings.

Text Books:

1. Machine Design –An Integrated approach, Robert L. Norton, Prentice-Hall, 1998.

2. Mechanical Design: Theory methodology, Manjula B Waldron and Kenneth J.Waldron, Springer Verlag, New York, 1996.

3. Product design & Manufacturing by A.K Chitale& R.C Gupta, PHI, 3rd Edition.

Reference Books:

1. Engineering Design: A materials and processing approach, George Dieter, McGraw-Hill, 1983.

2. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M. Marshek, John Wiley & Sons, 2nd edition, 1991.

3. Product Design by Chitale, P.H.I.

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(14MD11T02) ADVANCED MECHANICS OF SOLIDS

Course Objectives:

- To understand the strain/displacement and Hooke's law relationships
- To solve torsion problems in bars and thin walled members
- To solve for stresses and deflections of beams under unsymmetrical loading
- To locate the shear center of thin wall beams

Course Outcomes:

After Completion of this course students will be able to

- Understand and analyze stresses and strains at a point.
- Design straight beams, curved and asymmetrical bending of beams.
- Analyze and determine beams under unsymmetrical loading.
- Apply shear center of thin wall beams, torsion & ax symmetric problems

Unit I

Shear center: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections.
Unsymmetrical bending: Bending stresses in Beams subjected to Non symmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

Unit II

Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.
Torsion : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section ;Hollow thin wall torsion members ,Multiply connected Cross Section.

Unit III

Contact stresses: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

Unit VI

Two Dimensional Elasticity Problems: Plane stress & Plain strain-Problems in Rectangular Co-ordinates, bending of cantilever loaded at the end, bending of a beam by uniform load.

Two Dimensional Elasticity Problems: in polar co-ordinators, general equations in polar coordinates, stress distribution symmetrical about an axis, pure bending of curved bars, displacements for symmetrical stress distributions, rotating discs.

Unit V

Introduction to Three Dimensional Problems: Uniform stress stretching of a prismatic bar by its own weight, twist of circular shafts of constant cross section, pure bending of plates.

Textbook:

1. Advanced Mechanics of materials by Boresi & Sidebottom-Wiely International.
2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition

References:

1. Advanced strength of materials by Den Hortog J.P. J.P. McGraw-Hill Book Co., New York, 1952 edition.
2. Theory of plates – Timoshenko McGraw-Hill, 1959.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia preface to the third edition.
4. Strength of materials by Sadhu singh Khanna Publishers.

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(14MD11T03) FATIGUE, CREEP & FRACTURE MECHANICS

Course Objectives:

- Introduce students to the concepts of materials fracture and failure analysis.
- Equip them with knowledge on how to design against catastrophic failures and skills required in carrying out failure analysis.

Course Outcomes:

After Completion of this course students will be able to

- Identify and explain the types of fractures of engineered materials and their characteristic features.
- Understand the differences in the classification of fracture mechanics (LEFM and EPFM) and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service.
- Understand and explain the mechanisms of fracture; and learn how to carry out engineering failure analysis.
- Appreciate the theoretical basis of the experimental techniques utilized for fracture and failure analysis.

UNIT- I:

Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, the ductile/brittle fracture transition temperature for notched and un notched components. Fracture at elevated temperature.

UNIT II:

Griffith's analysis: Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.

Linear Elastic Fracture Mechanics, (LEFM): Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor.

UNIT III:

The effect of Constraint, definition of plane stress and plane strain and the effect of component thickness. The plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size. Limits on the applicability of LEFM..

Elastic-Plastic Fracture Mechanics; (EPFM). The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

UNIT-IV:

The effect of Microstructure on fracture mechanism and path, cleavage and ductile failure, factors improving toughness.

Fatigue: definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodman's rule and Miners rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

UNIT-V:

Creep deformation: the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

Text Books:

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
3. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
4. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
5. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).

References:

1. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)
2. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003).
3. G. E. Dieter, Mechanical Metallurgy, McGraw Hill, (1988)
4. D.C. Stouffer and L.T. Dame, Inelastic Deformation of Metals, Wiley (1996)
5. F.R.N. Nabarro, H.L. deVilliers, The Physics of Creep, Taylor and Francis, (1995).

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(14MD11T04) COMPUTATIONAL METHODS

Course Objectives:

- The objective of this course is to teach students mathematical derivations, implementation in a computer code, typical characteristics, advantages, disadvantages and limitations of appropriate numerical methods to solve a range of mathematical problems encountered in the practice of advanced engineering, namely:
- Finding solution to non-linear equations.
- Computing numerical derivatives and integrals for complex functions and discrete engineering data.
- Finding solutions to systems of linear equations and non-linear equations.
- Approximating data using mathematical functions.
- Finding solutions of ODEs and PDEs under different boundary and initial conditions.

Course Outcomes:

After Completion of this course students will be able to

- Understand and estimate errors due to round-off in the computer representation of numbers and errors in the numerical methods due to truncation and their implications to the stability and accuracy of the computational results.
- Compute the roots of non-linear equations and solve systems of linear equations using appropriate numerical methods for the given problem.
- Perform numerical integration and differentiation for a given function using a suitable numerical method.
- Perform interpolation, extrapolation, and curve-fitting for a set of data using different numerical methods.
- Solve several types of ODEs and PDEs with various boundary conditions using numerical techniques.
- Use a computer language of their choice to solve problems using numerical methods covered in the course.

Unit I

Introduction to numerical methods applied to engineering problems, Examples.

Approximations and Round-Off Errors: Significant Figures, Accuracy and Precision, Definition of Errors, Round-off Errors, Taylor Series, Propagation of errors, Sources of Error.

Roots of Non-Linear Equations: Bisection Method, False Position Method, Fixed Point Iteration Method, Newton-Raphson Method, Secant Method, Multiple roots, Computer Programs.

Unit II

Solving sets of equations: Matrix notation, Determinants and inversion, Gaussian Elimination, LU-Decomposition and Gauss-Siedel Method, System of non-linear equations, computer programs.

Numerical integration: Newton-Cotes integration formulas, Simpson's rules, Gaussian quadrature, Adaptive integration, Computer programs.

Unit III

Interpolation: Newton's Divided Difference and Lagrange interpolation methods, Coefficients of on an interpolating polynomial, Piece-wise interpolation and splines.

Curve fitting and approximation of functions: Least square approximation, fitting of non-linear curves by least squares regression analysis, multiple-linear regression, non-linear regression, computer programs.

Unit IV

Solutions of Ordinary Differential Equations: Euler Method, Runge-Kutta Methods, Solution through a set of equations Boundary value problems and characteristic value problems Shooting method, Derivative boundary conditions, Characteristic value problems, computer programs.

Unit V

Numerical solutions of partial differential equations: Laplace's equations, Representation as a difference equation, Iterative methods for Laplace's equations, Poisson equation, Examples, Derivative boundary conditions, Matrix patterns, sparseness, ADI method, computer programs.

Parabolic PDEs: Explicit method, Crank-Nicolson method, Derivative boundary Condition, Stability and convergence criteria, computer programs.

Hyperbolic PDEs: Solving wave equation by finite differences, stability of numerical method, method of characteristics, wave equation in two space dimensions, computer programs.

TEXT BOOK:

1. Steven C.Chapra, Raymond P. Canale "Numerical Methods for Engineers" Tata Mc Graw Hill.
2. Curtis F.Gerald, partick.O.Wheatly,"Applied numerical analysis"Addison-wesley,1989
3. Douglas J..Faires,Riched Burden"Numerical methods"Brooks/cole publishing company,1998.Second edition.

References:

1. Ward cheney &David Kincaid "Numerical mathematics and computing"Brooks/cole Publishing company1999,fourth edition.
2. Riley K.F.M.P.Hobson&Bence S.J,"mathematical methods for physics and engineering"Cambridge university press,1999.

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(14MD11T05) THEORY OF ELASTICITY & PLASTICITY

Course Objectives:

- To understand the theory of stress, strain and plasticity
- To enlighten the advances in plasticity and plastic strain analysis.
- To obtain the stress strain relation within the elastic body.
- To find the principle stress and strain for a different types of elastic body.
- To known yield criteria for ductile metal.
- To understand the plastic stress-strain relations.
- To learn Upper and lower bound theorems and corollaries

Course Outcomes:

After Completion of this course students will be able to

- Understand the stress and strain tensor field.
- Understand the contact stresses analysis problem in bearing.
- Understand advanced concepts of plasticity and plastic deformation analysis
- Students can demonstrate Idealized stress-strain diagrams for different material models
- They can demonstrate experimental verification of the Prandtl-Reuss equation
- Solve two and three dimensional problems of cylindrical bodies.
- Know the stress strain relation for a body subjected to loading within elastic limit.

Unit-I

Revision: Stress transformation and Strain transformation at a point in an elastic body, 3D Problems, Rigid body translation and rotation of an element in space. Generalized Hook law, Separation of Elastic Strains and rigid body displacement for a general displacement field u, v, w. Principal Stress and Strains.

Unit-II

Two Dimensional Problems in Elasticity- Plane Stress and Plane Strain Problems. Differential equations of equilibrium and compatibility equations. Boundary Conditions & Stress Functions Problems in Rectangular coordinates, Polynomial solutions, Cantilever loaded at the end, Simply supported load beam under uniformly distributed load, linear loading. Two dimensional problems in polar coordinated, stress distribution symmetrical about an axis, pure bending of curved bar, Displacement for symmetric loaded cases, bending of curved bar by forces at end. Effect of circular hole in plate under in plane loading. Concentrated load at point of Straight boundary. Stresses in circular disk. Forces acting on end of wedge.

Unit-III

Three dimensional problems in Elasticity. Differential equation of equilibrium in 3D, Condition of Compatibility, Determination of Displacement, Principal of superposition, Uniqueness theorem. Problems of Rods under axial stress, Bar under its own weight, Pure bending of Prismatic roads. Torsion of Prismatic bars of Elliptical, rectangular, triangular and other sections. Membrane analogy-Torsion of narrow rectangular bars. Torsion of hollow shaft and thin tubes.

Unit-IV

Bending of Prismatic bars as a problem of elasticity in 3D. Bending of a cantilever, Stress function, Circular and rectangular sections, Non symmetrical cross section. Shear centre for different cross sections of bars, Calculation of deflections. Energy Theorems-Applications of complimentary energy theorems to the problems of elasticity.

Unit-V

Introduction to plasticity, Criteria of yielding, strain hardening, rules of plastic flow, different stress strains relations. Total Strain theory, theorems of limit analysis. Elastoplasic bending and torsion of bars.

TEXT BOOKS:

1. Wang, "Applied Elasticity", McGraw hill book Co.
2. Timoshenko, "Theory of Elasticity", McGraw hill book Co.
3. J. Chakrabarti, "Theory of Plasticity", McGraw hill book Co.

References:

1. Plasticity for Engineers: Johnson & Mellor.
2. Fundamentals of Theory of Plasticity: L.M. Kachanov
3. Elasticity in Engineering: Ernest E. Sechler, Dover Publications Inc., 1968
4. Applied Elasticity: C.T. Wang, McGraw Hill Book Co. 1953.

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(14MD11E1a) ADVANCED COMPUTER AIDED DESIGN

Course Objectives:

- Model the 3-D geometric information of machine components including assemblies, and automatically generate 2-D production drawings, understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces.
- Integrate the CAD system and the CAM system by using the CAD system for modeling design Information and converting the CAD model into a CAM model for modeling the manufacturing Information.
- Use full-scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information.

Course Outcomes:

After Completion of this course students will be able to

- Understand the concepts of wireframe, surface and solid modeling.
- Understand part modeling and part data exchange standards (VDA, IGES, and STEP).
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Understand the Assembly Modeling, Assembly tree, and Assembly Methods.
- The Students become experts on Visualization and computer animation Techniques.

UNIT – I:
Introduction to CAD

Introduction to CAD: Introduction to CAD, CAD input devices, CAD output devices, CAD Software, Typical Product Cycle, Implementation of CAD process, Application of CAD, Benefits of CAD, Requirements of geometric modeling, Geometric construction methods, Modeling features: Drafting features, modeling features, editing features, annotations, dimensioning, tolerance and hatching features, display control features, analysis and optimization features, programming features, plotting features.

UNIT – II:
Modeling

Modeling Tools: Coordinate system, limits, grid, snap, line type and line weight, basic geometric commands, layers, display control commands, editing commands.
Feature based Modeling: Introduction, Feature Entities, Parametric, and Feature Manipulations.
Geometric Modeling: Types of curves and curve manipulations, Types of surfaces and surface manipulations,
Solid modeling: Geometry and Topology, Boundary representation (B-rep), Constructive Solid Geometry (CSG) – Euler – Poincare formula - examples, Sweeping, Solid manipulations.

UNIT – III:
Transformations and Mechanical tolerancing

Transformations: 2D and 3D Transformations.
Product data Exchange: Evaluation of data – exchange format, IGES data representations and structure, STEP Architecture.
Geometric tolerance: Datum's, types of tolerances, tolerance modeling and representation, tolerance analysis: worst-case arithmetic method, worst-case statistical method, Monte Carlo simulation method.

UNIT-IV: Mass properties and Mechanical assembly

Mass Property Calculations: Mass, centroid, Moment of inertia, second moments and product of inertia, property mapping.
Collaborative Design: Traditional design, Collaborative Design, Principles and Approaches.
Assembly Modeling: Introduction, Assembly Modeling, Assembly Tree, Assembly Planning, Mating Conditions, Bottom – Up and Top – Down Assembly Approaches with examples

UNIT-V:
Visualization and Computer animations

Visualization: Introduction, Model clean up, Hidden -Line Removal, Hidden Surface Removal, Hidden Solid Removal, Shading, Colors.
Computer Animation: Introduction, Conventional animation, Computer animation, Entertainment animation, Engineering animation, Animation types, Animation techniques.

TEXT BOOKS:

1. Mastering CAD/CAM, Ibrahim Zeid, TMH, New Delhi
2. CAD/CAM Concepts and Applications, Alavala, PHI, New Delhi

REFERENCES:

1. CAD/CAM, PN Rao, PHI
2. Computer Graphics, Alavala, PHI, New Delhi
3. Computer integrated Manufacturing, Harrington, Huntington, New York.
4. Computer integrated design and Manufacturing, Bedworth D.D, McGraw Hill, New York.
5. Computer Graphics and Animation, M.C.Trivedi, JAICO
6. Computer aided Design in Manufacturing, Valliere, Prentice Hall, New Jersey.

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(14MD11E1b) MATERIAL TECHNOLOGY

COURSE OBJECTIVES:

- To gain and understanding of the relationship between the structure, properties, processing, testing and applications of strengthening mechanism, modern metallic, smart, non-metallic, advanced structural ceramic and composite materials so as to identify and select suitable materials for various engineering applications.

Course Outcomes:

After Completion of this course students will be able to

- Students will get knowledge on mechanism of plastic deformation andstrengthening mechanism.
- Students will be able to learn the structure, properties and applications of modern metallic materials, smart materials non-metallic materials and advanced structural ceramics.
- Students will be able to understand the importance of advanced composite materials in application to sophisticated machine and structure of components.

Unit – I

Classification of materials and their properties, Bonds in Solids, Crystallographic planes and directions, Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.

Unit – II

Poly phase mixture, precipitation, particle, fiber and dispersion strengthening , effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non-crystalline material.

Unit – III

Modern metallic Materials:Iron-Iron Carbide Diagram, TTT Diagram, Dual phase steels, high strength low alloy (HSLA) Steel, transformation induced plasticity (TRIP) Steel, maraging steel, intermetalics, Ni and Ti aluminides.

Smart materials Classification, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

Unit – IV

Non-metallic materials: Polymeric materials Classification, properties and applications, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers.

Advanced structural ceramics: Ceramic materials Classification, properties and applications, WC, TiC, TaC, Al2O3, SiC, Si3 N4, CBN and diamond-properties, processing and applications.

Unit – V

Advanced structural composites: Introduction, types of composite materials, properties, processing and application.

Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep.

TEXT BOOKS:

1. Mechanical behavior of materials/Thomas H.Courtney/2nd Edition, McGraw-Hill, 2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill, 1998
3. Introduction to Physical Metallurgy, Sidney H. Avner, US, 2nd Edition, 2007 Tata McGrawHill, Noida, 1985.

REFERENCES:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. Materials Science and Engineering, William D. Callister, 8th Edition, 2010.
3. Material Science and Metallurgy, kodgire V.D, 12th Edition, Everest Publishing House 2002.

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(14MD11E1c) NON-DESTRUCTIVE EVALUATION

***Course objective*:**

- To understand the principles behind various NDT techniques.
- To study about NDT equipments and accessories.
- To learn working procedures of various NDT techniques.

Course Outcomes:

After Completion of this course students will be able to

- Demonstrate good grounding in the area of NDT.
- To select proper NDT Method for his application
- Understand the utilization of test and measurement appropriate to the area of his study/problem

Unit – I

Ultra Sonic Hardness Testing: Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents.

Holography: Principles and practices of Optical holography, acoustical, microwave, xray and electron beam holography techniques.

Unit – II

Introduction to X-Ray Radiography: The Radiographic process, X-Ray and Gamma ray Sources, Geometric Principles, Factors Governing Exposure, Radio graphic screens, Scattered Radiation, Arithmetic of exposure, Radiographic image quality and detail visibility, Industrial X-ray films.

Unit – III

X-Ray Radiography processes: Fundamentals of processing techniques, Process control, the processing Room, Special Processing techniques, Paper Radiography, Sensitometric characteristics of x-ray films, Film graininess signal to noise ratio in radiographs, the photographic latent image, Radiation Protection

Unit – IV

Introduction to Ultrasonic Testing: Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- straight beam,direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, Fscan and P-scan modes.

Unit – V

Ultrasonic tests:

Flaw sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi-modal transducer, Zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echos and noise. Ultrasonic flaw evaluation.

Applications
1. NDT in flaw analysis of Pressure vessels, piping
2. NDT in Castings, Welded constructions, etc., Case studies.

TEXT BOOKS:

1. Ultrasonic testing by Krautkramer and Krautkramer
2. Ultrasonic inspection 2 Training for NDT : E. A. Gingel, Prometheus Press.

Reference:

1. ASTM Standards, Vol 3.01, Metals and alloys.

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(14MD11E1d) TRIBOLOGY IN DESIGN

Course Objectives:

- Understanding the principles for selecting compatible materials for minimizing friction and wear in machinery.
- Understanding the principles of bearing selection and bearing arrangement in machines.
- Learn the computations required for selecting and designing bearings in machines.
- Understanding the fundamental principles of lubrication for reduction of friction and Wear.
- Understanding the fundamental principles of high contact stresses (Hertz stresses),
- Fatigue-failure and Elastohydrodynamic (EHD) lubrication in rolling bearings and gears.

Course Outcomes:

After Completion of this course students will be able to

- Students will demonstrate basic understanding of friction, lubrication and wear processes.
- Students will become familiar with mathematical tools used to analyze tribological processes.
- Students will become familiar with common anti-friction and anti-wear components and the lubricants used therein.
- Students will be able to describe the detailed operation of selected anti-friction or anti-wear components.

Unit – I

SURFACES, FRICTION AND WEAR: Nature of surfaces and contact-Surface topography-friction and wear mechanisms and effect of lubricants- methods of fluid film formation. Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load-bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

Unit – II

LUBRICANTS AND LUBRICATION REGIMES : Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection – selection of pump, filters, piping design- oil changing and oil conservation. Dry and marginally lubricated contacts - Boundary Lubrication - Hydrodynamic lubrication - Elasto and plasto hydrodynamic – Magneto hydrodynamic lubrication - Hydro static lubrication - Gas lubrication.

Unit – III

Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum film thickness.

Unit – IV

Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness-journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure. **Dry rubbing Bearings:** porous metal bearings and oscillatory journal bearings – qualitative approach only.

Unit – V

Seals & Failure of Tribological components: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals. Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.

Text Books:

1. Rowe WW& O' Dionoghue,"Hydrostatic and Hybrid bearing design " Butterworths & Co. Publishers Ltd,1983.
2. Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.
3. Bernard J.Hamrock, "Fundamentals of fluid film lubricant", Mc Graw-Hill Co.,1994.
4. Neale MJ, (Editor) "Tribology hand Book"Neumann Butterworths, 1975.

Reference:

1. Connor and Boyd JJO (Editors) "Standard hand book of lubrication engineers ASLE,Mc Graw Hill Book & Co.,1968
2. Shigley J, E Charles," Mechanical Engineering Design", McGraw Hill Co., 1989
3. *S.K.Basu*, S.N.Sengupta&B.B.Ahuja,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd, New Delhi, 2005.

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M.Tech. I SEMESTER (MD)	**3**	**2**

(14MD11P01) ADVANCED COMPUTER AIDED DESIGN &ANALYSIS LAB

Note: Conduct at least any ten exercises from the list given below:

Course Objectives:

- Model the 3-D geometric information of machine components including assemblies, and automatically generate 2-D production drawings, understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces.
- Integrate the CAD system and the CAM system by using the CAD system for modeling design Information and converting the CAD model into a CAM model for modeling the manufacturing Information.
- Use full-scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information.

Course Outcomes:

After Completion of this course students will be able to

- Understand the concepts of wireframe, surface and solid modeling.
- Understand part modeling and part data exchange standards (VDA, IGES, and STEP).
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Understand the Assembly Modeling, Assembly tree, and Assembly Methods.
- The Students become experts on Visualization and computer animation Techniques.

1. Two- dimensional drawing using CAD software.
2. Three-dimensional drawing using CAD software.
3. Various Dimensioning and tolerance technique son typical products using CAD software.
4. Assembly and animation of simple assemblies like screw jack, bolt-nut mechanism, etc.
5. Truss analysis using FEA software.
6. Beam analysis using FEA software.
7. Frame analysis using FEA software.
8. Buckling analysis of columns using FEA software.

9. Harmonic analysis using FEA software.

10. Fracture analysis using FEA software.

11. Analysis of laminated composites using FEA software.

12. Couple-field analysis using FEA software.

13. Modal Analysis.

14. Transient dynamic analysis.

15. Spectrum analysis

References:

User manuals of ANSYS package Version 14.0
PRO/E, I-DEAS Package /UNIGRAPHICS, CATIA.

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(14MD12T06) ADVANCED MECHANISMS

Course Objectives:

- Understand the fundamentals of the theory of kinematics and dynamics of machines.
- Study of Kinematics of various mechanisms and Kinematics synthesis of linkages.
- Study of various graphical constructions of acceleration analysis.
- To represent graphical and analytical method of dimensional synthesis.
- Kinematics analysis and kinematics synthesis of spatial mechanisms.
- Understand techniques for studying motion of machines and their components.

Course Outcomes:

After Completion of this course students will be able to

- Distinguish kinematic and kinetic motion.
- Identify the basic relations between distance, time, velocity, and acceleration.
- Apply vector mechanics as a tool for solving kinematic problems.
- Create a schematic drawing of a real-world mechanism.
- Determine the degrees-of-freedom (mobility) of a mechanism.
- Use graphical and analytic methods to study the motion of a planar mechanism.

Unit-I

Introduction: Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms-spherical trigonometry.

Unit-II

Advanced Kinematics of plane motion: The Inflection circle ; Euler – Savary Equation; Analytical and graphical determination of di ; Bobillier's Construction ;Collineation axis ; Hartmann's Construction ;Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

Advanced Kinematics of plane motion : Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem;

Unit-III

Synthesis of Linkages: Function generation, Path generation and Body guidance, precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanism, Crank - rocker mechanisms with optimum transmission angle motion generation

Unit-IV

Graphical and Analytical Methods of Dimensional Synthesis: Two position synthesis of Crank -rocker mechanisms, three position synthesis, Fourth position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, analytical synthesis using complex algebra.

Unit – V

Manipulator kinematics: D-H notation, D-H convention of assignment of co-ordinate frames and link parameters table; D-H transformation matrix ; Direct and Inverse kinematic analysis of Serial manipulators: Articulated ,spherical & industrial robot manipulators- PUMA, **SCARA,STANFORD ARM, MICROBOT**.

Manipulator kinematics – II: Differential kinematics Formulation of Jacobian for planar serial manipulators and spherical manipulator; Singularity analysis.

Text books:

1 George N. Sandor and A.G. Erdman, "**Advanced Mechanism Design analysis and Synthesis"**, Vol.1 and 2, Prentice Hall of India, 1984.

2 Shigley J.E and Uicker J.J., **"Theory of Machines and Mechanisms",** McGraw Hill, 1995.

3 Hall, **"Kinematics and Linkage Design"**, Prentice Hall, 1964.

References:

1 .Robert L. Norton, **"Design of Machinery",** McGraw Hill, 2003.

2. Hartenberg and Denavit, **"Kinematics and synthesis of linkages",** McGraw Hill, 1964.

3. J.Hirschhorn, "**Kinematics and Dynamics of Plane Mechanisms"**, McGraw Hill, 1962.

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(14MD12T07) MECHANICAL VIBRATIONS

Course Objectives:

- Students will be able to learn how to deal with the phenomena of vibrations by transforming the physical model into a mathematical model. Getting the response of a physical model by solving the mathematical model, analyzing the response and bring its physical concept.

Course Outcomes:

After Completion of this course students will be able to

- Students will understand the causes and effects of vibration in mechanical systems and their classification.
- Students will be able to solve vibration problems that contain multiple degrees of freedom and obtain design parameters.
- Students will be able to learn how the vibration measuring instrument works and how to apply the proper instrument for a particular application.
- Students will be able to analyze a system with infinite degrees of freedom and also be able to find infinite natural frequencies corresponding to infinite principle modes of the systems.
- Students could also be able to apply various numerical methods to solve determinants of higher order when one deals with multi-degree freedom systems.

Unit I

Single degree of Freedom systems: Newton's Laws, D.Alembert's principle, Energy methods. Free vibrations, free damped vibrations, and forced vibrations with and without damping, base excitation. Coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation; Vibration isolation and transmissibility.

Unit II

Multi – Degree of freedom systems: Two degrees of freedom systems, Static and dynamic couplings, Eigen values, Eigen vectors and orthogonality conditions of Eigen vectors, Matrix formulation, stiffness and flexibility influence coefficients; Vibration absorber, Principal coordinates, Principal modes.

Unit III

Vibration measuring instruments: Vibrometers, velocity meters and accelerometers.

Critical speeds of shafts: Critical speeds with and without damping, secondary critical speed.

Unit IV

Vibration of Continuous systems: Free vibration of strings, longitudinal vibrations of bars, traverse vibrations of beams, torsional vibrations of shafts. Torsional vibrations of multi–rotor systems and geared systems.

Unit V

Numerical Methods: Rayleigh's method, Stodola's method, Matrix iteration method, Rayleigh – Ritz Method, Holzer's method and Dunkerley's method.

Modal analysis: Free and forced vibration by Modal analysis

Text books:

1. Elements of Vibration Analysis by Meirovitch, Tata McGraw - Hill Education

2. Mechanical Vibrations by G.K. Grover, Nem Chand And Brothers publishers.

References:

1. Vibrations by W.T. Thomson, person edition

2. Mechanical Vibrations – Schaum's series.

3. Vibration problems in Engineering by S.P. Timoshenko.

4. Mechanical Vibrations – V.Ram Murthy.

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(14MD12T08) ENGINEERING OPTIMIZATION TECHNIQUES

Course Objectives:

- To understand the formulation of a structural optimization problem, including defining appropriate design variables, constraints, and objective functions.
- To apply various approximation methods to construct a sequence of approximate structural design problems appropriate for static strength, natural frequencies, buckling, and dynamic response.
- To apply appropriate algorithms for discrete design variables and multi objective optimization problems.

Course Outcomes:

After Completion of this course students will be able to

- Strengthen the analytical skills of the students.
- Able to apply the optimization techniques in various applications.

Unit - I

Classical Optimization Techniques: Engineering applications of optimization, statement of optimization problem, classification of optimization problem, single variable optimization, multi variable optimization with no constraint, equality constraint, in-equality constraint.

Unit -II

Linear Programming: Simplex algorithm, two phases of the simplex method, applications.

Unit - III

Non-Linear Programming: One-dimensional minimization - exhaustive search, golden section method, quasi-Newton method, random search methods, Powell's method.

Unit -IV

Modern Methods of Optimization: Genetic algorithms, simulated annealing, fuzzy optimization, neural-network-based methods.

Unit -V

Topology Optimization: Problem formulation and parameterization of design, solution methods, topology optimization as a design tool, combining topology and shape design, buckling problems, stress constraints.

TEXT BOOKS

1. Singiresu.S.Rao., "Engineering Optimization Theory and Practice" New AgeInternational (P) Limited, Publishers 1996.
2. Kalyanamody Deb, "Optimization for Engineering design algorithms and examples"Prentice Hall of India Pvt 1995.

References

1. Structural Optimization, Raphael T. Haftka and ZaferGurdal, Kluwer Academic Publishers.
2. Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer.
3. Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund.
4. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley, 2010.

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(14MD12T09) EXPERIMENTAL STRESS ANALYSIS

Course Objectives:

- To understand the relation between the mechanics theory and experimental stress analysis.
- To establish the fundamental concepts and newly experimental techniques.
- To be able to use the experimental techniques on the practical problems.
- To be able to make a fine presentation related to the experimental paper.

Course Outcomes:

After Completion of this course students will be able to

- Of the application basic science systematization thought excavation, the evaluation, the diagnosis project question, and plans and carries out ability of the special study and the solution.
- Have independent research, collection the data, standard problem take into analytical the identification acquire conclusion, and have development innovation and compose the ability of professional thesis.
- Usage mathematics engineering realm is related analysis and design software, explanation data with independently solve the ability of problem.
- Has mathematical and the project professional field self-study, the innovation ponder and ability of the sustained development.

UNIT – I

Introduction: Theory of Elasticity, Plane stress and plane strain conditions, Compatibility conditions.

Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits.

UNIT – II

Recording Instruments

Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

UNIT --III

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

UNIT-IV

Photo elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light,

Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics

Three dimensional Photo elasticity:

Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear-difference method in three dimensions, applications of the Frozen-stress method, the scattered-light method.

UNIT-V

Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Birefringent Coatings

Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

Text books :

1. Theory of Elasticity by Timoshenke and Goodier Jr

2. Experimental stress analysis by Dally and Riley,Mc Graw-Hill

References:

1. A treatise on Mathematical theory of Elasticity by LOVE .A.H

2. Photo Elasticity by Frocht

3. “Experimental Stress Analysis” by Sadhu Singh – Khanna Publishers, New Delhi, 1996.

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(14MD12T10) FINITE ELEMENT ANALYSIS

Course Objectives:

- Apply vector mechanics as a tool for problem solving.
- Understand the need in Design for the Finite Element Method.
- Tie his/her understanding of mechanical engineering design concepts to use the Finite Element Method software correctly and efficiently.
- Analyse a physical problem, develop experimental procedures for accurately investigating the problem, and effectively perform and document findings.
- Understand forces associated with different parts of a machine

Course Outcomes:

After Completion of this course students will be able to

- Numerical methods involved in Finite Element Theory.
- Definition of truss, beam, membrane, plate, and continuum elements.
- Formulation of planar one-dimensional (truss and beam) elements having linear, quadratic, and cubic shape functions.
- Global, local, and natural coordinates.
- Formulation of planar, plane stress two-dimensional elements (rectangular and quadratic quadrilateral elements).
- Formulation of 3-dimensional elements (four-node tetrahedral and eight-node brick elements).
- Direct formulation and basic energy and weighted residual formulation of finite elements.
- Procedures for performing and verifying FEA using commercial FEA software.

UNIT -I:

Introduction to FEM: Basic concepts, historical back ground, application of FEM, general description, comparison of FEM with other methods, variation approach, Galerkin MethodsCo-ordinates, basic element shapes, interpolation function. Virtual energy principle, Rayleigh- Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain displacement relations

UNIT -II:

1-D structural problems – axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape function. Analysis of Trusses – Plane Truss and Space Truss elements.

UNIT -III:

Analysis of beams – Hermite shape functions – stiffness matrix – Load vector – Problems, 2-D problems –CST, LST, force terms, Stiffness matrix and load vector, boundary conditions.

UNIT – IV:

Isoperimetric element – quadrilateral element, Shape functions – Numerical Integration – sub parametric and super parametric elements.3-D problems – Tetrahedron element – Jacobian matrix – Stiffness matrix.

Scalar field problems - 1-D Heat conduction – 1-D fin element – 2-D heat conduction problems – Introduction to Torsional problems.

UNIT -V:

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen Vector, natural frequencies – mode shapes – modal analysis.

Non linearity, Introduction, Non linear problems, geometric non linearity, non linear dynamic problems, analytical problems.

TEXT BOOKS:

1. Introduction to Finite Elements in Engineering – Tirupathi K. Chandrupatla and Ashok D. Belagundu.
2. Concepts and applications of finite element analysis – Robert Cook
3. The Finite Element Methods in Engineering – S.S. Rao - Pergamon, New York

REFERENCE BOOKS

1. An Introduction to Finite Element Methods – J. N. Reddy – Mc Graw Hill.
2. The Finite Element Methods in Engineering science – O.C. Zienkowitz, Mc Graw Hill.
3. Finite Element Procedures in Engineering analysis – K.J Bathe.

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(14MD12E2a) PRESSURE VESSEL DESIGN

Course Objectives:

- The objective of this course is to acquire basic understanding of design Parameter, complete knowledge of design procedures for commonly used process equipment and their attachments.
- This course also emphasis on the knowledge of loss prevention, personal safety, industrial safety, hazard analysis and personal proactive equipment.

Course Outcomes:

After Completion of this course students will be able to

- Knowledge of basics of process equipment design and important parameters ofequipment design
- Ability to design internal pressure vessels and external pressure vessels
- Ability to design special vessels (e.g. tall vessels) and various parts of vessels.

UNIT – I

Introduction, Materials- shapes of Vessels –stresses in cylindrical spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load bending and torque-ilation of pressure vessels –conical and tetrahedral vessels.
Theory of thick cylinders; Shrink fit stresses in built up cylinders – auto freltage of thick cylinders Thermal stresses in Pressure Vessels.

UNIT – II

THEORY OF RECTANGULAR PLATES : Pure bending – different edge conditions.
Theory circular plates: Simple support and clamped ends subjected to concentrated and uniformly distributed loads-stresses from local loads. Design of dome bends, shell connections, flat heads and cone openings.

UNIT – III

DISCONTINUITY STRESSES IN PRESSURE VESSELS: Introduction beam on an elastic foundation, infinitely long beam semi infinite beam, cylindrical vessel under axially symmetrical loading, extent and significance of load deformations on pressure vessels, discontinuity stresses in vessels, stresses in a bimetallic joints, deformation and stresses in flanges.
Pressure vessel materials and their environment : Introduction ductile material tensile tests, structure and strength of steel Leuder's lines determination of stress patterns from plastic flow observations, behavior of steel beyond the yield point, effect of cold work or strain hardening on the physical properties of pressure vessel steels fracture types in tension. Toughness of materials, effect of neutron irradiation of steels, fatigue of metals, fatigue erack growth fatigue life prediction cumulative fatigue damage stress theory of failure of vessels subject to steady state and fatigue conditions.

UNIT IV

STRESS CONCENTRATIONS: Influence of surface effects on fatigue, effect of the environment and other factors on fatigue life thermal stress fatigue creep and rupture of metals at elevated temperatures, hydrogen embitterment of pressure vessel steels brittle fracture effect of environment on fracture toughness, fracture toughness relationships criteria for design with defects, significance of fracture mechanics evaluations, effect of warm prestressing on the ambient temperature toughness of pressure vessel steels.

UNIT V

DESIGN FEATURES: Localized stresses and their significance, stress concentration at a variable thickness transition section in a cylindrical vessel, stress concentration about a circular hole in a plate subject to tension, elliptical openings, stress concentration, stress concentration factors for position , dynamic and thermal transient conditions, theory of reinforced openings and reinforcement, placement and shape fatigue and stress concentration.

Textbooks:

1. Theory and design of modern Pressure Vessels / John F. Harvey 'Van/ Nostrand Reihold company / New York.
2. Pressure Vessel Design and Analysis / Bickell M. B. Ruizes / Macmillan Publishers
3. Process Equipment design / Beowll & Yound Ett.

References:

1.Indian standard code for unfired Pressure vessels IS 2825.
2.Pressure Vessels Design Hand Book Henry H. Bednar PE / CB S Publishers / New Delhi.
3.Theory of plates and shells / Timoshenko& Noinosky / Dover Publications.
4.Stress in Beams, Plates and Shells / Ansel C. Ugural / CRC Press / 3rd Edition.

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(14MD12E2b) ROBOTICS

Course Objectives:

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in perform kinematics analysis of robot systems.
- To provide the student with some knowledge and analysis skills associated with Trajectory planning.
- To provide the student with some knowledge and skills associated with robot control.

Course Outcomes:

After Completion of this course students will be able to

- Classify robots based on joints and arm configurations.
- Design application specific End Effectors for robots.
- Compute forward and inverse kinematics of robots and determine trajectory plan.
- Program robot to perform typical tasks including Pick and Place, Stacking and Welding.
- Design and select robots for Industrial applications.

Unit – I

Fundamentals of Robots: Introduction, definition of robot, classification of robots, History of robotics, robot components, degree of freedom, robot joints, robot coordinates, reference frames, programming modes, robot characteristics, robot work space, robot languages, advantages, disadvantages and applications of robots.

Unit – II

Matrix transformations: Introduction, robots as a mechanisms, matrix representation-representation of a point in a space, representation of a vector in space, representation of a frame at the origin of a reference frame, representation of a frame in a reference frame, representation of a rigid body.

Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis, representation of combined transformations, transformations relative to the rotating, inverse of transformation matrices.

Robot kinematics: Forward and inverse kinematics of robots-forward and inverse kinematic equations for position, forward and inverse kinematic equations for orientation, forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg (D-H) representation of forward kinematic equations of robots, The inverse kinematic solution and programming of robots, Degeneracy and Dexterity, simple problems with D-H representation.

Unit – III

Trajectory planning: Introduction, path Vs trajectory, basics of trajectory planning, joint space trajectory planning-third order polynomial trajectory planning, fifth order polynomial trajectory planning, Cartesian-space trajectories.

Differential motions and Velocities:

Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

Unit – IV

Dynamic analysis and forces: Introduction, Lagrangian mechanics, Effective moments of inertia, dynamic equations for multi-degree of freedom robots-kinetic enrgy,potential energy, the Lagrangian,robot's equations of motion, static force analysis of robots.

Unit – V

Robot Actuators: Introduction,charecterics of Actuating systems-weight, power to weight ratio, operating pressure, stiffness Vs compliance,comparision of actuating systems, hydraulic devices, pneumatic devices, Electric motors-DC motorcar motors, Brushless DC motors, direct Drive electric motors, servomotors, stepped motors.

Robot sensors: Introduction, sensor characteristics,Position sensors-potentiometers, encoders, LVDT, Resolvers, time of travel displacement sensor, Velocity sensors-Encoders, Tachometers, differentiation of position signal,Accelerating sensors, force and pressure sensors-piezoelectric, force sensing resistor, strain gauges, Torque sensors, light and infrared sensors, touch and tactile sensors, proximity sensors-magnetic proximity sensors, optical proximity sensors, Ultrasonic proximity sensors, inductive proximity sensors, capacitive proximity sensors, eddy current proximity sensors, sniff sensors.

Text Books:

1. Introduction to Robotics – Analysis, System, Applications by Saeed B. Niku, PHI Publications

2. Industrial Robotics – Mikell P. Groover & Mitchell Weiss, Roger N. Nagel,Nicholas G.Odrey – Mc Graw Hill, 1986

References:

1. Robot Modeling and Kinematics – Rachid Manseur, Firewall Media Publishers (An imprint of Laxmi Publications Pvt. Ltd., New Delhi)

2 Robot Analysis and Control - H. Asada and J.J.E. Slotine John Willey & Sons.

3. Fundamentals of Robotics: Analysis and control, Robert J. Schilling, Prentice Hall, 1990.

4. A robot Engineering text book – Mohsen shahinpoor, Harper & Row Publishers,1987

5. Introduction to Robotics: Mechanics and Control, John.J.Craig, Addison- Wesley, 1999

6. Robotics: Control, sensing, vision, and intelligence – K.S. FU, R.C. Gonzalez and C.S.G Lee. Mc Graw Hill, 1987.

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(14MD12E2c) MECHANICS OF COMPOSITE MATERIALS

Course Objectives:

- Study the types of fibers and their structure and behaviors.
- Study the mathematical analysis of stresses acting on the composites.
- Expose to the various manufacturing processes & Testing methods of Composites.
- Understand the design principle.

Course Outcomes:

After Completion of this course students will be able to

- Fiber characteristics and methods of production of fibers
- The suitable composite manufacturing process when designing intricate and critical parts made of composites
- The testing methods of composites thoroughly and practical input obtained
- The failure of composites well and the production of quality composites with design life ensured.

UNIT-I

Introduction to Composite Materials: Introduction ,Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber-Reinforced Composites and nature-made composites, and applications.

Reinforcements: Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT-II

Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.**Macromechanical Analysis of a Lamina**:Introduction,Definitions: Stress, Strain, Elastic Moduli,Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

UNIT-III

Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio,Failure Envelopes, Maximum Strain Failure Theory, Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygrothermal Stresses and Strains in a Lamina: Hygro thermal Stress–Strain Relationships for a Unidirectional Lamina, Hydrothermal Stress–Strain Relationships for an Angle Lamina.

UNIT-IV

Micromechanical Analysis of a Lamina: Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi-Empirical Models,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion.

UNIT-V

Macromechanical Analysis of Laminates: Introduction,Laminate Code, Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates.

Failure, Analysis, and Design of Laminates: Introduction , Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues.

Text Books:

1.Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.

2.B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.

3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw ,Publisher: CRC

References:

1. R. M. Jones, Mechanics of Composite Materials, McGraw Hill Company, New York, 1975.

2. L. R. Calcote, Analysis of Laminated Composite Structures, Van NostrandRainfold, New York, 1969.

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(14MD12E2d) GEAR ENGINEERING

(PSG Design data Book to be used and allowed in Examinations)

Course Objectives:

- To develop an ability to design a system, component, or process to meet desired needs with in realistic constraints.
- To develop an ability to identify, formulate, and solve engineering problems.
- To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Course Outcomes:

After Completion of this course students will be able to

- Ability to select appropriate materials for a design, considering manufacturability, availability, cost, performance, suitability for the conditions, potential failure modes, environmental impact, and other considerations.
- Ability to evaluate the importance of an engineering decision, select an appropriate decision making process, and implement that process to make a defensible engineering decision
- Ability to model, analyze, design, and realize a mechanical system that meets a particular need.

Unit – I

Introduction: Principles of gear tooth action, Generation of Cycloid and Involute gears, gear manufacturing processes and inspection, Analysis of gear tooth failures, gear-casing problems, lubrication failures, stresses, and selection of right kind of gears.

Unit – II

Spur Gears & Helical Gear: Tooth loads, Principles of Geometry, Design considerations and methodology, complete design of gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Unit – III

Bevel Gears & Worm Gear: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

Unit – IV

Gear trains: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

Unit – V

Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques.

Text Books:

1. Maleev and Hartman, Machine Design, C.B.S. Publishers, India.

2. Henry E.Merrit,Gear engineering ,Wheeler publishing,Allahabad,1992.

3. Practical Gear design by Darle W. Dudley, McGraw-Hill Book Company

References

1. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York, 1949.

2. G.M.Maitra, Hand book of gear design, TaTa Mc.Graw Hill publishing company Ltd., New Delhi, 1994.

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(UGC - AUTONOMOUS)

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M.Tech. I SEMESTER (MD)	**3**	**2**

(14MD12P02) DYNAMICS LAB

Course Objectives:

- To equip students with understanding of the fundamental principles and techniques for Identify different types of dynamic systems and classify them by their governing equations
- To develop a model of a mechanical system using a free body diagram
- To develop equations of motion for translational and rotational mechanical systems
- To develop an understanding of how property data is generated and reported.
- To create a bridge between theoretical knowledge and application.

Course Outcomes:

As an outcome of completing this course, students will be able to:

- Plan, conduct, analyze and evaluate experiments
- Compare analytical and theoretical results
- Produce reports
- Communicate test results through presentation (graphical or oral)

Experiments:

1. Determination of damped natural frequency of vibration of the vibrating system with different viscous oils
2. Determination of steady state amplitude of a forced vibratory system
3. Static balancing using steel balls
4. Determination of the magnitude and orientation of the balancing mass in dynamic balancing
5. Field balancing of the thin rotors using vibration pickups.
6. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
7. Determination of natural frequency of given structure using FFT analyzer
8. Diagnosis of a machine using FFT analyzer.
9. Direct kinematic analysis of a robot
10. Inverse kinematic analysis of a robot
11. Trajectory planning of a robot in joint space scheme.
12. Palletizing operation using Robot programming.